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HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII
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NATURAL AND ARTIFICIAL INCUBATION OF HENS' EGGS

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NATURAL AND ARTIFICIAL INCUBATION OF HENS' EGGS

By

C. M. Bice, *Poultry Husbandman, and* F. G. Botelho, *Foreman.*

INTRODUCTION

Artificial incubation has been practiced from very ancient times. Records are extant which give reliable information concerning methods of incubation by the early Egyptians. The incubators were made of reed baskets and were lined with fermenting manure to heat the eggs. This crude method gave excellent results, due to the skill of the operators. Artificial incubation has been carried on in China for centuries, and the incubators satisfactorily used there to-day are similar in construction and management to the earlier devices. (Fig. 1.)

Fig. 1.—A battery of Chinese incubators.
(Courtesy H. L. Chung)

The basket type of incubator was followed by the oven type of greater capacity. Commercial hatching began with the advent of the oven incubator. The hatchery was located so that a large number of eggs could be gathered near by. The eggs were contracted for by the hatchery owner and the resultant chicks were sold at a nominal sum per hundred, or exchanged for old iron, brass, etc.[1] Thermometers were not in use in the early days. The eggs were taken from the oven at irregular intervals and the temperature was determined by the "feel" to the eyelids, face, or hands. This method of testing required long years of experience, and was handed down from generation to generation, usually being kept within certain families. It is still in use in China.

Although artificial incubation is a relatively new practice in North America, large commercial hatcheries are to be found in every State in the Union. Thousands of chicks are produced annually and sold to poultrymen. Artificial incubation has made the poultry industry a billion-dollar enterprise. Large machines called mammoth incubators hold as many as 53,000 eggs at a time. Hatcheries having a capacity of 1,800,000 eggs at one "setting," produce 75,000 chicks daily during the peak season. These figures show the tremendous growth of the poultry industry within the past 10 years.

NATURAL INCUBATION

In some respects the hen is still superior to the incubator in the process of hatching. Inherited characteristics and instincts provide for the requisite ventilation, moisture and temperature conditions, and for turning the eggs. Many amateur and back-lot poultry producers depend upon the hen for incubation because they have no capital with which to purchase a machine or have had little or no experience with artificial incubation.

SELECTING THE HEN

Success in natural incubation is dependent upon the type of hen selected for the purpose. The hen should have good health, be docile and of medium size, and have nonfeathered shanks. She should also

[1]Chinese Incubators. U. S. Dept. Agr., Bureau of Animal Industry Rpt. 1900, pp. 247-259, illus.

have the broody instinct well developed and be large enough to cover the required number of eggs. Breeds of the general-purpose type, such as Plymouth Rocks, Rhode Island Reds, and Wyandottes, make excellent sitters and mothers. Certain strains of the Mediterranean breeds will sit, but can not always be relied upon to hatch a setting of eggs. The Asiatic breeds are too large for sitters and frequently break the eggs.

CONSTRUCTING THE NEST

The nest should be roomy to prevent the eggs from being broken by the hen and to provide for her comfort. Sitting hens prefer to brood in a quiet, out-of-the-way place that is protected from enemies. A suitable bank of nests for Hawaiian conditions should be 36 inches long, 12 inches high, and 14 inches deep. Place a partition every 12 inches apart in the bank to provide for three nests. A longer bank of nests may be made if desired and partitioned at 12-inch intervals. The front of the nest should be made of wire to safeguard against invasion by rodents and to keep the nest cool. (Fig 2.)

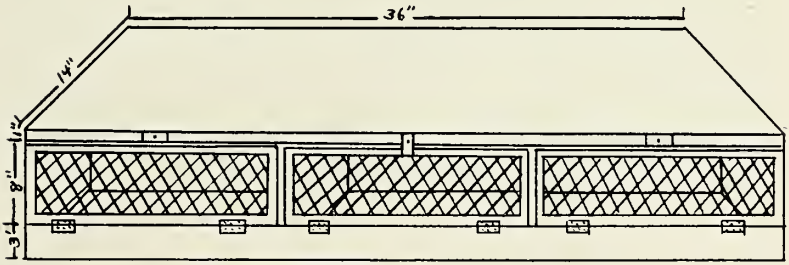

Figure 2—A bank of nests for sitting hens. More than three to a bank may be made if desired.

Place the nest on the ground unless the mongoose or other enemies are prevalent, in which case build the nest in a poultry house that is rodent proof. When the nests are to be made in the poultry house, or above the ground, put a piece of grass sod or some damp earth in the bottom of the nest and hollow it slightly in the center before adding the nesting material. The sod or damp earth will provide suitable moisture conditions for successful hatching.

SETTING THE HEN

Transfer the hen at night to the place where she is to remain for the hatching period. Before placing her on the nest dust her with sodium fluoride powder, working it well into the feathers, especially those around the vent and under the wings. (Fig. 3.) Do not place the eggs in the nest until the hen has remained there for

Fig. 3.—Applying sodium fluoride by the "pinch method" to a hen preparatory to placing her on the nest.

a day or two. Place infertile or artificial eggs in the nest for the first day or two. If the hen remains on the nest place 12 to 15 eggs for hatching under her. The number will depend upon the size of the hen. If the nest has been used previously, carefully inspect it for lice and for mites and if they are present clean and spray the nest, using creoline or other commercial poultry-house spray. Cleanliness is very essential for success in natural incubation.

FEEDING THE HEN

Place before the hen at least once each day whole grains, greens,

grit, charcoal, and fresh water. No wet mash or dry mash is fed during the sitting period. A dust bath should be placed where the hen may have free access to it during feeding time. Placing a small quantity of a mixture of tobacco dust and earth in the dust bath will aid in exterminating lice and mites.

SUGGESTIONS ON MANAGING THE HEN

(1) Set several hens at one time.

(2) Test the eggs at least twice during the incubation period, preferably on the seventh and fourteenth days, and remove infertile and deadgerm eggs.

(3) Watch the air cell for proper moisture conditions. The air cell should gradually increase in size.

(4) Remove broken eggs from the nest, replace the nesting material with clean straw, hay, or chaff, and wash the soiled eggs.

(5) If the hen is restless at hatching time, remove the chicks from the nest as soon as they are dry.

(6) Keep the hen and the nest free from vermin.

(7) Do not feed the hen wet or dry mash.

(8) Provide fresh water for her daily.

(9) Feed her whole grains, greens, and grit.

(10) Select the right hen for the purpose.

PERIOD OF INCUBATION

The period of incubation varies with different kinds of poultry, as is shown in the following table:

Table 1.—Period of Incubation of Fowls

Kind of fowl.	Number of days required for eggs to incubate.
Hen	21
Turkey	28
Duck	28
Duck (Muscovy)	35-37
Goose	28-32
Pheasant	21-24
Guinea	26-28
Ostrich	42
Pigeon	18-20
Peafowl	28

ARTIFICIAL INCUBATION

By artificial incubation is meant the hatching of baby chicks from eggs in a mechanical device, known as an incubator. Incubators have several advantages over the broody hen for the production of chicks. The capacity of the mammoth incubator makes it possible to hatch chicks in larger units at one time for commercial purposes. The use of the modern incubator eliminates guesswork, reduces the labor involved to a minimum, and puts the cost of production on a more economical basis.

TYPES OF INCUBATORS

There are two general classes of incubators in use in Hawaii, a small kind, in which heat is supplied by electricity or by kerosene, and a mammoth kind, in which heat is supplied by electricity or by coal. (Figs. 4 and 5.)

The main difference between the two kinds is the method used to heat the air for the maintenance of the proper temperature. In incubators that are supplied with kerosene or with coal the air is heated in pipes and diffused throughout the machine. Where electricity is used the air is heated by coming in contact with resistant wires or other heating elements.

SELECTION AND CARE OF EGGS FOR HATCHING

The eggs selected for hatching should be uniform in size, color, and

Fig. 4.—A good hatch in a small electric incubator.

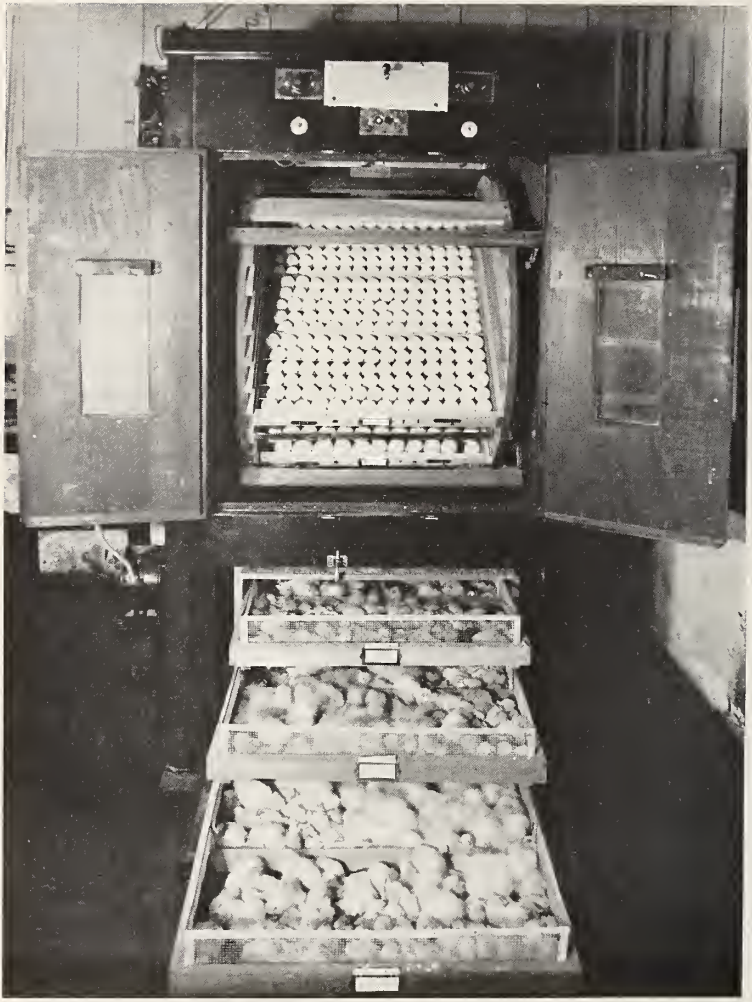

Fig. 5.—A fine hatch in a cabinet type of mammoth incubator.

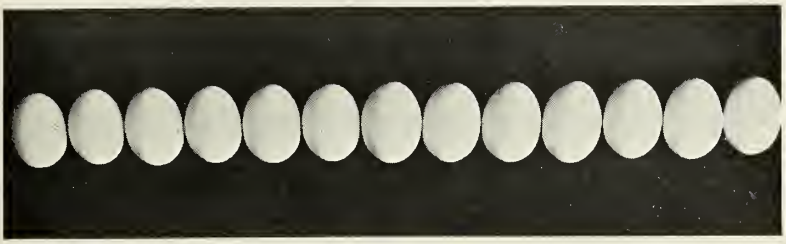

Fig. 6.—A good setting of eggs, regular in shape and size.

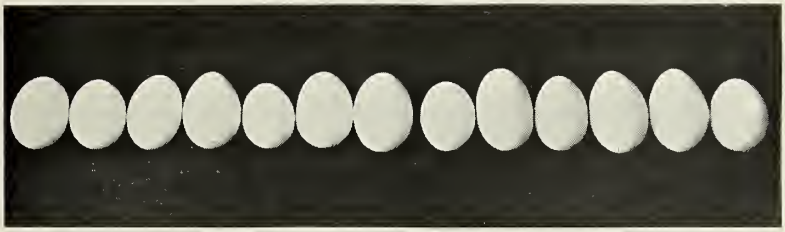

Fig. 7—A poor setting of eggs, irregular in shape and size.

shape, and have well-textured shells. (Figs. 6 and 7.) Extremely large or small eggs are undesirable. Eggs weighing between 24 ounces and 26 ounces per dozen are best for hatching purposes. Small eggs have been found to produce small chicks. These chicks in turn lay small eggs, and their continued use would result in a depletion of constitutional vigor of stock—making it undesirable—and a decrease in the size of eggs. In the selection of eggs for hatching it is well to remember that the market price of eggs in Hawaii is based upon size of egg. Therefore, since the correlation between the size, shape, and color of the egg used and the size, shape, and color of chicks hatched is high, poor eggs should be eliminated at hatching time rather than the bird culled from the flock later.

After the eggs have been selected as to size, shape, and color, remove all dirt that is adhering to them. It is better practice to scrape off the dirt rather than to wash it off. Care should be taken not to remove any more of the natural bloom than is necessary. However, very dirty eggs should be washed.

HOLDING THE EGGS

At times it is necessary to hold the eggs for 10 to 14 days before placing them in the incubator. Under Hawaiian conditions the eggs should not be held longer than 5 days. However, provided that they are kept where there is a good circulation of air, they may be kept for 14 days. Eggs that are to be held for 14 days should be placed under a temperature ranging from 55° to 60° F. and turned once a day. (Fig. 8.)

STARTING THE INCUBATOR

Start the incubator a day or two before the eggs are placed in the machine in order to make certain that it is functioning properly. The room temperature should be kept between 75° and 80° F. Such a range will give the best circulation of air. Most machines depend upon differences of room temperature and incubator temperature to provide proper ventilation within the incubator. The eggs should not be crowded on the trays. If the eggs have been kept in a cool place, put them on incubator trays and keep on top of the incubator for 12 to 24 hours before placing them in the machine.

TEMPERATURE

There is some controversy as to whether a uniform temperature throughout the period of the hatch is better than a varied temperature. Observations of temperatures under a sitting hen showed that the temperature varies. The eggs in the center of the nest are warmer than those at the edge, and during the process of turning the eggs assume new temperature positions in the nest. Excellent hatches were made under the following temperatures:

(a) Standing thermometer used. Placed level with the top of the eggs but not touching them. The temperatures were 102° F. for the first week, 102 1/2° for the second week; and 103 1/2° for the third week.

Fig. 8.—Eggs are held under a temperature ranging from 55° to 60° F. in this cabinet before being placed in the incubator. Eggs held for 17 days gave good hatches.

(b) Hanging thermometer used. Placed 2 inches above the eggs. The temperature remained at 104° F. for the first, second, and third weeks.

(c) Thermometer rested on fertile egg. The temperatures were 101° F. for the first week; 102° for the second week; and 103° for the third week.

The cabinet type of incubator used at the station has temperature rating of 99 1/2° to 100° F. Several successful trials were made under a temperature of 100° F. throughout the period of the hatch. This temperature was found to be desirable for use under Hawaiian conditions.

Correct temperature plays an important role in the production of strong, liveable chicks. Test the thermometer for accuracy by comparing it with a clinical thermometer of known readings. This will assure correct temperature readings.

TURNING THE EGGS

Turn the eggs twice daily from the second to the eighteenth day. Turning four times daily gives excellent results. When the eggs are not turned regularly, the percentage of dead germs increases. Turning is of special importance during the early part of the hatching period.

COOLING THE EGGS

Cooling the eggs is not necessary except in certain cases. Cooling helps when the incubator temperature is too high or the machine is poorly ventilated. The length of time required to turn the eggs is sufficient to cool them, except under conditions already mentioned. Cool the eggs for 5 minutes during the first week, for 10 minutes during the second week, and for 15 minutes during the third week when necessary. Incubation at 100° F. does not require cooling of the eggs.

VENTILATION

The primary function of ventilation in an incubator is to supply oxygen to the developing embryo and to remove the carbon dioxide given off by it. Proper ventilation in the incubator can be secured only when the room ventilation is correct. The greater the ventilation and the colder and drier the air in the incubator room, the greater the evaporation of moisture from the eggs. Ventilation and moisture are closely related factors, the amount of each depending upon the other. Ventilation and moisture may be controlled by noting the size of the air cell during the incubation period, or by weighing the eggs to determine the moisture loss. (Fig. 9.)

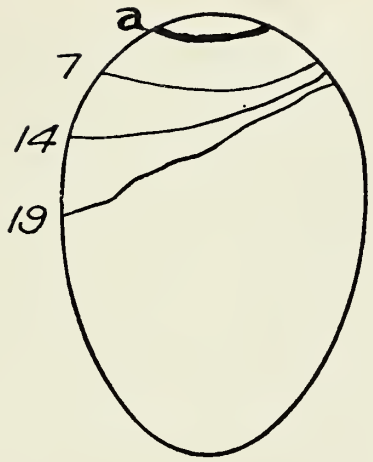

Fig. 9.—Test for proper moisture conditions during incubation. **a**, Fresh egg; 7, seventh day of incubation; 14, fourteenth day; and 19, nineteenth day.

MOISTURE

In the trials made with the incubator kept at a temperature of 100° F. throughout the period of the hatch, no additional moisture was necessary. When moisture was added the chicks could not emerge from the eggs. Too much moisture in the egg chamber thus prevents the normal evaporation necessary for the chick to turn in the egg and break the shell and renders hatching impossible. Several chicks drowned in the eggs owing to the excess of moisture. The moisture loss during the period of incubation is approximately 3.5 to 4 per cent during the first 6 days, 4 to 4.5 per cent during the sixth to twelfth day, and 4.5 to 5 per cent during the twelfth to eighteenth day—a total loss of 12 to 13.5 per cent.

There are several methods of supplying moisture in incubators. The incubator room floor may be sprayed with water; a pan of water may be placed on the floor of the nursery compartment; a dampened burlap sack may be placed in the nursery compartment; or steam may be applied in certain makes of incubators. The amount of moisture to supply and the time to supply it vary with localities.

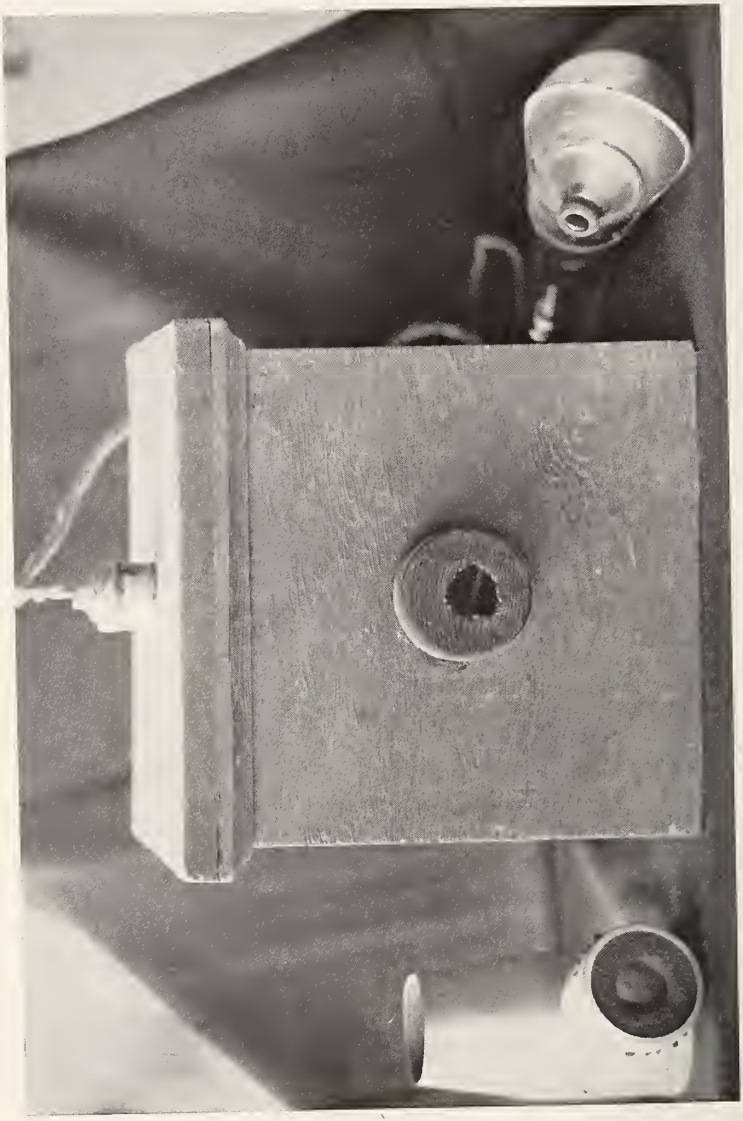

Fig. 10.—Testing devices for candling eggs during incubation.

TESTING THE EGGS

Test the eggs on the seventh and fourteenth days for infertility and for dead germs and remove from incubator. Various kinds of testing devices may be used. (Fig. 10.)

Infertile eggs appear perfectly clear before the candling device. Dead-germ eggs appear on the seventh day to have blood rings or blood clots. Fertile eggs on the seventh day have a dark area from which radiate several blood vessels. (Fig. 11.)

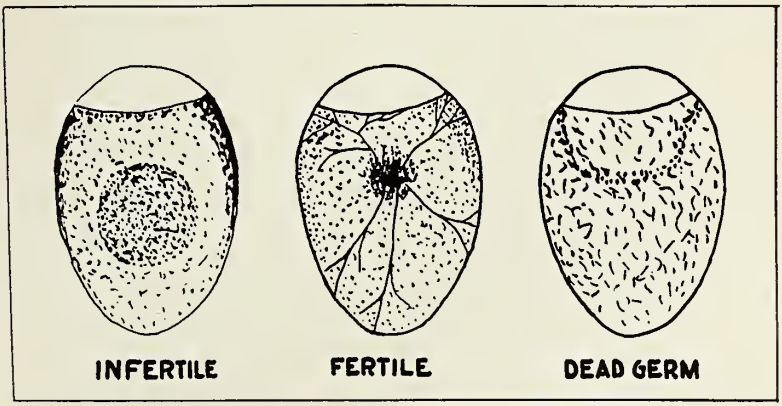

Fig. 11.—Appearance of infertile, fertile, and dead-germ eggs on the seventh day.

On the fourteenth day dead-germ eggs appear to be cloudy or to have blood rings. The eggs containing strong living embryos appear very dark on the fourteenth day, showing a clear, distinct line between the air cell and the growing embryo.

EIGHTEENTH-DAY MANAGEMENT

Eggs should not be turned after the eighteenth day of incubation. The temperature should be held uniform. When the machines have been kept under a temperature of 100° F. up to the eighteenth day, a rise of 1/2° to 1° F. may occur from the nineteenth day until the date of hatching. This additional heat is given off by the embryos in the eggs. Do not change the regulation at this time. The incubator

door should remain closed after the eighteenth day except when it is necessary to remove chicks or shells. Darken the incubator on the eighteenth day. There are several advantages in darkening the incubator: The chicks remain where they hatch and are well scattered on the tray, or they may sleep and build up resistance to disease. Lastly, they can not eat the droppings.

Never let the chicks fall to the nursery compartment. Keep them on the hatching tray until they are dry, then remove them from the incubator and place them in lots of 100 in chick boxes. (Fig. 4.) Keep them in these boxes for 24 hours and then transfer them to the brooders for their first feed.

PEDIGREE HATCHING

Pedigree hatching is practiced where it is desired to know the parents of each chick. This necessitates the hatching of chicks from each hen in individual pedigree baskets, sacks, or trays. It is good practice to put all the eggs from one hen on the same tray in the incubator so that on the eighteenth day no time will be lost in transferring the eggs to the pedigree baskets, trays, or sacks. The second test for live germs may be made on the eighteenth day at the time the eggs are transferred. Thus dead eggs will not occupy space in the baskets. The usual test on the fourteenth day may be made if desired, and then followed by another test on the eighteenth day.

On the eighteenth day the eggs from the pedigreed hens are transferred to a basket, sack, or tray, those from each hen being placed together. The number of the hen is placed on a small card that is attached to the container. Thus the ancestry can be determined at hatching time by referring to the number on the card. (Fig. 12.)

When the hatch is completed the chicks are removed and banded. The band is first rolled about the leg of the chick and later is transferred to the wing. (Figs. 13 and 14.) The band should be removed from the leg before becoming too small and causing injury to the leg. The band may be placed in the wing the first day. The chicks may be toe-punched for future identification. (Fig. 15.)

It is necessary to keep accurate records in pedigree work if success is expected to follow. The chick record book should contain such information as is tabulated on page 22.

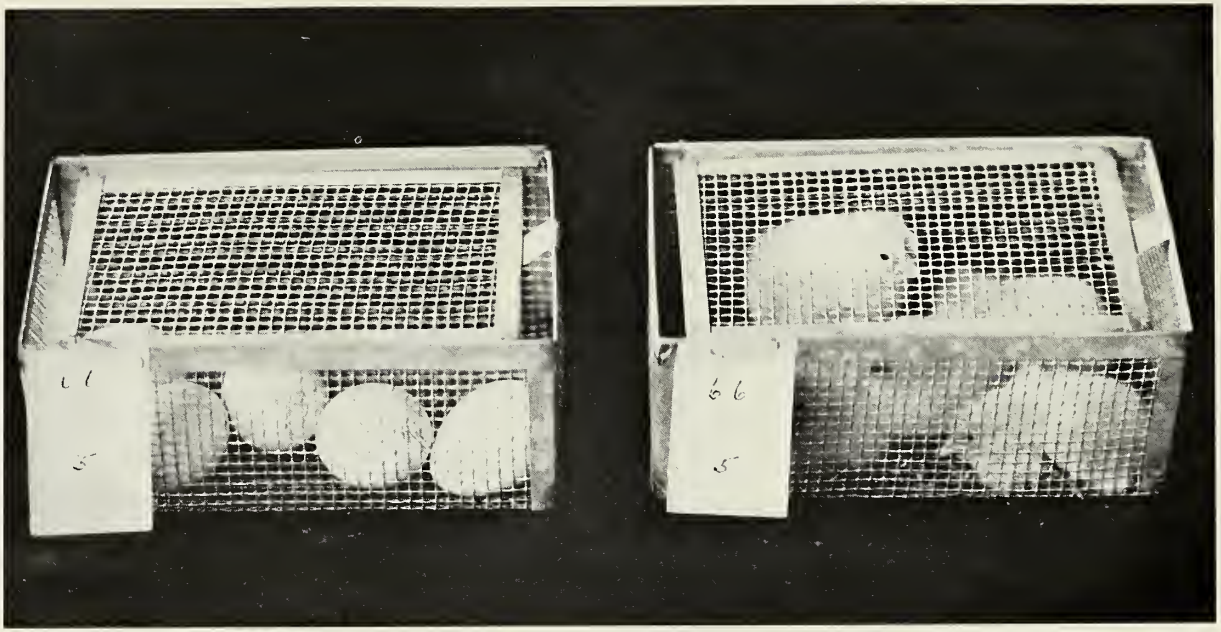

Fig. 12—On the 18th day the eggs from pedigreed hens are placed in individual baskets with the number of the hen on a card attached to the basket.

Fig. 13.—Leg band on a day-old chick.

Fig. 14.—Wing band in web of wing. This band was transferred from the leg to the wing when the chick was 2 weeks old. It is to remain in place permanently.

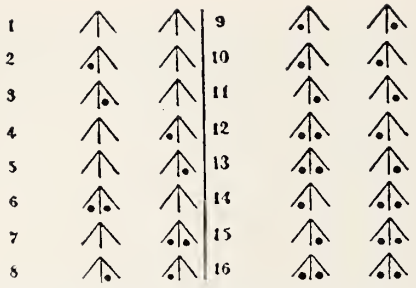

Figure 15.—Toe punching is an accurate method of marking chicks for future identification. The hole in the web does not grow over as the bird matures.

POULTRY DIVISION
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CHICK RECORD SHEET

Leg band number	Wing band number	Date hatched	Dam number	Sire number	Sex	Disposal
160	436	1/6/30	800A	1549	♀ [1]	
161	810	Do.	756A	1820	♂ [2]	Dead. 9/20/30
162	920	Do.	192A	1432	♀ [1]	

[1] Female.

[2] Male.

The records during the hatching period are shown in Figure 16, Incubator record sheet.

The progeny record is made from the chick-record book after the pullets have come into production. (page 23.)

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INCUBATOR RECORD SHEET

Machine | TEMPERATURE OF INCUBATOR | OPERATOR

Date																												
Days Incubating	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
5 A. M.																												
8 A. M.																												
12 M.																												
3 P. M.																												
6 P. M.																												
9 P. M.																												

VARIETY

No. of Eggs

Per cent strong chicks based upon total eggs

Per cent strong chicks based on fertile eggs

Per cent eggs fertile

Per cent fertile eggs hatched

Pen No.	Tray	No. Eggs	Infertile	Per cent all eggs hatched D 1	D 2	D 3	Rejected	Healthy Hatched	R	L

Fig. 16.—Incubator Record Sheet. (after J. G. Halpin.)

POULTRY DIVISION
HAWAII AGRICULTURAL EXPERIMENT STATION

Season of: 1931-32

Leg Band No.: 412 Wing Band No. 1432

Sire	Chick band number.	Adult band number.	1st.	2nd.	3rd.	Notes.
No. 78	2437	847				
No. 69	2874	966				